

## CLAIMS

1. A three-dimensional camera based position determination system, comprising:  
an optically scannable target device fixedly attached to a target object;  
at least one camera and light subsystem, each subsystem having:  
  - an image sensing device configured to view the optically scannable target device and to generate image information indicative of geometric characteristics of the target device; and
  - at least one invisible light emitting diode operatively coupled to a strobe circuit, the at least one diode and circuit being configured to emit strobed invisible light thereby illuminating the optically scannable target such that the light is retro-reflected to the image sensing device and the image sensing device detects and forms an image of the target; and  
a data processing device operatively coupled to the image sensing device, the data processing device being configured to determine the orientation of the target object based on the generated target image.
2. The position determination system as recited in Claim 1, wherein the invisible light is infrared light.
3. The position determination system as recited in Claim 2, further comprising:  
a visible indicator that emits light within the visible spectrum, thereby indicating that the at least one invisible light emitting diode is operative.
4. The position determination system as recited in Claim 1, wherein the at least one invisible light emitting diode is an array of light emitting diodes.

5. The position determination system as recited in Claim 4, wherein the number of invisible light emitting diodes in the array is sixty-four.

6. The position determination system as recited in Claim 4, wherein the number of invisible light emitting diodes in the array is eighty.

7. The position determination system as recited in Claim 1 wherein the target object is a vehicle wheel, and the data processing device is further configured to determine proper wheel alignment based on orientation of the vehicle wheel.

8. The position determination system as recited in Claim 3, wherein the image sensing device includes an electronic shutter that is synchronized with the at least one strobed light emitting diode such that an image is captured only when a target is illuminated.

9. The position determination system as recited in Claim 8, wherein the image sensing device is a charge-coupled device video camera.

10. The position determination system as recited in Claim 8, wherein the image sensing device is a complimentary metal oxide semiconductor camera.

11. The position determination system as recited in Claim 1, further comprising:  
a rotation device configured to rotate, prior to use, one or more invisible light emitting diodes on a circuit board such that illumination from the invisible light emitting diodes to the target device is more evenly distributed.

12. The position determination system as recited in Claim 1, further comprising:

a current source configured to supply a current to the at least one invisible light emitting diode.

13. A three-dimensional camera based position determination system, comprising:

an optically scannable target device fixedly attached to a target object;

at least one camera and light subsystem, each subsystem having:

an image sensing device configured to view the optically scannable target device and to generate image information indicative of geometric characteristics of the target device; and

at least one light emitting diode operatively coupled to a strobe circuit, the at least one diode and circuit being configured to emit strobed light thereby illuminating the optically scannable target such that the light is retro-reflected to the image sensing device and the image sensing device detects and forms an image of the target;

a data processing device operatively coupled to the image sensing device, the data processing device being configured to determine the orientation of the target object based on the generated target image; and

a target object indicator that displays the status of target acquisition by the data processing device.

14. The position determination system as recited in Claim 13 wherein the target object indicator comprises:

a target object indicator array that includes at least one set of target object indicator light emitting diodes, wherein each light emitting diode of the first set corresponds to a target object;

wherein the target object indicator array further includes a second set of target object indicator light emitting diodes, wherein each light emitting diode of the second set corresponds to a target object; and

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wherein the target object indicator array is operatively coupled to the data processing device such that the first set of target object light emitting diodes is energized when an image of the target object is acquired by the data processing device, thereby indicating that the target object is acquired by the data processing device, and the second set of target object light emitting diodes is energized when an image of the target object is not acquired by the data processing device, thereby indicating that the target object is not acquired by the data processing device

15. The position determination system as recited in Claim 13, further comprising:

at least two sets of directional light arrays, each of the sets of directional light arrays including at least one directional light emitting diode, and wherein, the at least two sets of directional light arrays are operatively coupled to the image sensing device such that when a single set of directional light is energized, a direction is indicated in which the target object should be repositioned such that the image sensing device may sense the target object and wherein, when all directional light arrays are on, the target object has been properly positioned.

16. The position determination system as recited in Claim 1, wherein the number of directional light arrays is four, and the directions in which the vehicle should be repositioned as indicated by the four arrays are backward, forward, left and right.

17. A three-dimensional camera based position determination system, comprising:

sensing means for sensing an image of the target device, and generating image information indicative of geometric characteristics of the target device; and

emission means for emitting strobed invisible light that illuminates the optically scannable target such that the light is retro-reflected to the image sensing device and the image sensing device detects and forms an image of the target; and

data processing means for determining the orientation of the target object based on the generated target image.

18. The position determination system as recited in Claim 17, wherein the invisible light is infrared light.

19. The position determination system as recited in Claim 18, further comprising:  
a visible indicator means for emitting light within the visible spectrum, thereby indicating that the emission means is operative.

20. The position determination system as recited in Claim 17, wherein the target object is a vehicle wheel, and the data processing means is configured to determine proper wheel alignment based on orientation of the vehicle wheel.

21. The position determination system as recited in Claim 17, wherein the image sensing means includes an electronic shutter that is synchronized with the emission means such that an image is captured only when a target is illuminated.

22. The position determination system as recited in Claim 17, further comprising:  
attachment means for fixedly attaching an optically scannable target device to a target object.

23. The position determination system as recited in Claim 17, further comprising:  
directional means for indicating the direction in which a target object should be repositioned, and for indicating that a target object has been properly positioned.

24. The position determination system as recited in Claim 17, further comprising:

target object indicator means for indicating that the sensing means is sensing the target object.

25. The position determination system as recited in Claim 17, further comprising:

target object indicator means for indicating the state of target acquisition by the data processing device.